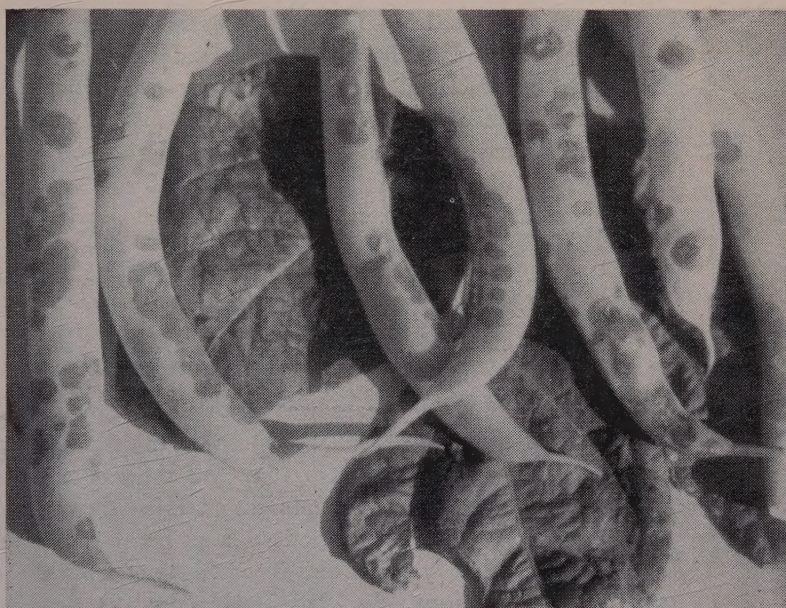


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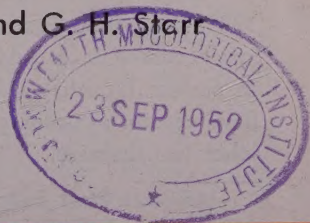
Bacterial Diseases Of Beans in Wyoming



Halo Blight on Pods of Snap Beans

By H. J. Walters and G. H. Starr

Bulletin
319



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G. D. HUMPHREY, President

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INTRODUCTION

BACTERIAL diseases are among the most important diseases of beans wherever climatic conditions are favorable during the growing season. Diseases do not restrict themselves to any one or more varieties; in years with optimum environmental conditions for development, epidemics are not unusual.

Greatest losses from bacterial diseases to the crop in Wyoming are caused by common blight, halo blight, and bacterial wilt. Each is caused by a different bacterial organism but may occur in the same locality and have certain similar symptoms. The causal organism may infect the stems, leaves, pods, and seeds and eventually kill the infected plant.

Purpose of this bulletin is to supply information dealing with control and other aspects of bacterial diseases of beans. The material presented herein is based on research conducted at the Wyoming Agricultural Experiment Station, Laramie, and at the Powell Substation, together with general information obtained from various sources.

HISTORY AND DISTRIBUTION

Common blight of beans was reported in New York and New Jersey as early as 1892 (1, 3),* but the causal organism was not isolated and its pathogenicity proved until 1896 (6). All references to a bacterial disease of beans referred to the common-blight organism for approximately 25 years. In 1924, halo blight was first noticed, and, because of severity of its attack, suspicion immediately arose that it was distinct from the other known bacterial disease of beans. In 1926, Burkholder (2) described the disease as occurring in New York State.

Bacterial wilt was first recognized and described as a new disease in 1922 (5). Investigation of this disease began in 1921, when a 25 percent loss occurred in a field of navy beans in South Dakota. Since wilt occurs in certain localities with common and halo blights, and the three diseases have certain symptoms in common, wilt may have been confused with the other two diseases.

¹Assistant Plant Pathologist and former Plant Pathologist, respectively, Wyoming Agricultural Experiment Station. Dr. Starr is now director of the Wyoming Agricultural Extension Service.

*Reference in parenthesis is to Literature Cited, page 12.

Damage from bacterial disease is reported practically every year from some area in Wyoming. There is no record establishing the first appearance of common and halo blights in the state. Bacterial wilt was first reported in 1937 and was estimated to have caused a 1.5 percent reduction in yield that season (8).

In 1947 fuscous blight, another bacterial disease caused by a strain of the organism responsible for common blight, was reported on Great Northern beans at Powell (7). Extent and importance of this disease in the state are not known.

Common and halo blight are prevalent in Colorado, Utah, Montana, and Wyoming and in all states east of the Rocky Mountains. Both diseases may occur in California, Idaho, Nevada, New Mexico, Washington, and Oregon, but they rarely cause enough loss to be of economic importance (4). Bacterial wilt has been reported from the District of Columbia, Maryland, Michigan, Montana, New York, North Dakota, Ohio, South Dakota, Oregon, West Virginia, and Wyoming (4). Zaumeyer and Thomas (9) reported bacterial wilt in Idaho in 1947. Fuscous blight has been reported from Colorado, Montana, and Wyoming (7).

It is not possible to separate losses caused by the individual bacterial disease. They frequently occur together in the same field and probably on the same plant. Severity of bacterial diseases varies from year to year depending on weather conditions and on presence of a source of inocula from infected seed or from infected refuse in the soil.

In general both dry- and snap-bean varieties are susceptible to common and halo blight and to bacterial wilt. Dry-bean varieties appear to be most susceptible to common blight with the snap-bean varieties susceptible to both common and halo blight. Bacterial wilt has been found on dry as well as on snap beans. Little is known about varietal susceptibility to fuscous blight.

SYMPTOMS

Common, Halo, and Fuscous Blights

Symptoms of common- and halo-blight diseases are very much alike. It is seldom possible from superficial examination to be certain which is present. In many cases isolation of the organism provides the only means of identification.

Probably the most characteristic symptoms of blight occur on the leaves of the plant. The first symptoms are small, water-soaked lesions, which may become necrotic, on the underside of the leaf or leaflets (Fig. 1). These lesions may enlarge and coalesce with similarly infected areas (Fig. 2A). With halo blight, a halo-like zone of greenish-yellow may be produced

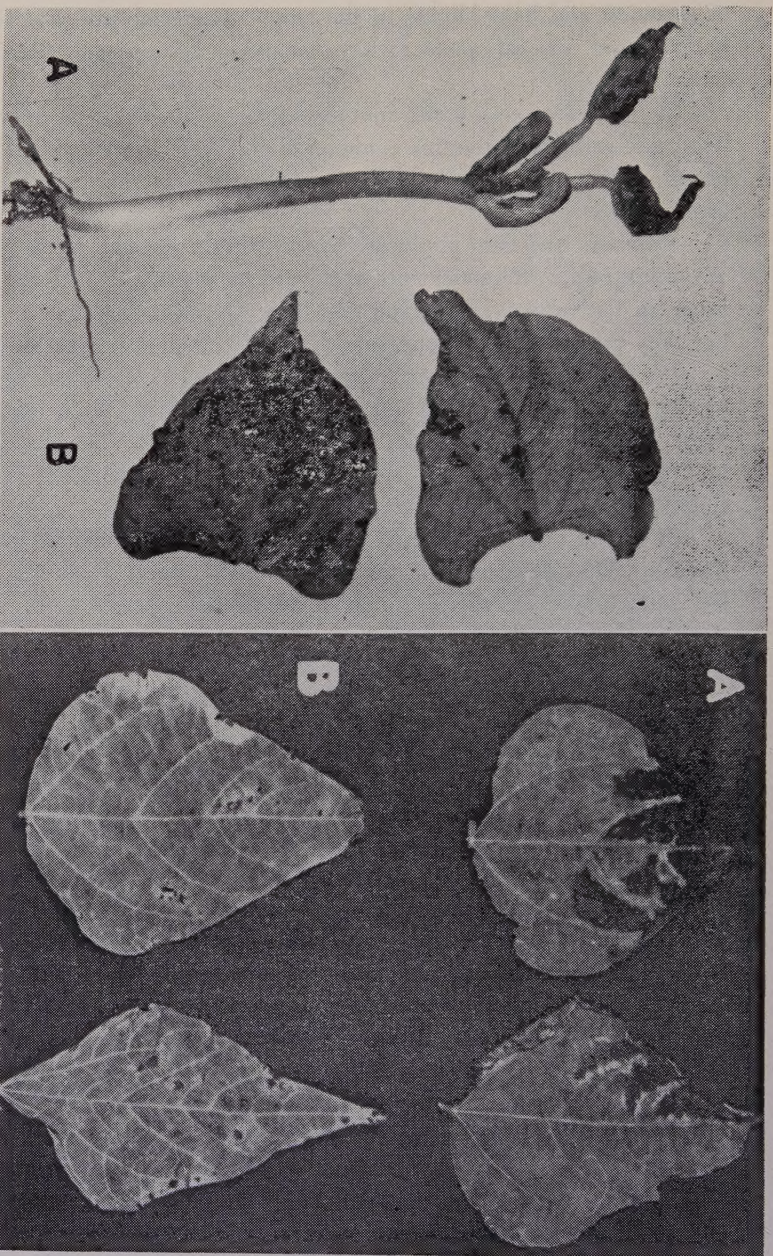


FIG. 1—(Left) Early infection of bacterial blight showing primary water-soaked lesions on (A), cotyledons and primary leaves of a seedling, and (B), primary leaves.

FIG. 2—(Right) Bacterial blight on leaves of beans. A, Common blight; the lesions have turned brown and have coalesced to form several extensive dead areas. B, Halo blight; each lesion is surrounded by a greenish-yellow halo which is a characteristic symptom of the disease under cool conditions. Some halos are very conspicuous while others are not.

outside the water-soaked area which aids in distinguishing between halo and common blight (Fig. 2B). This greenish-yellow area varies from a narrow band to a zone 1 inch in diameter (Fig 3). The halo spot is found, as a rule, during cool weather, while during hot weather another type of lesion occurs. The lesions of the latter type are usually numerous on the leaf, small and angular, with the chlorotic zone absent. Lack of a halo may also be due to the fact that the entire leaf is somewhat chlorotic.

If the bacteria enter the vascular or conducting tissue of the leaf, different symptoms develop. Initial infection usually begins in the small veinlets, from which the bacteria pass to the large veins and finally to the midrib. Severe infection produces reddish-brown discolorations with water-soaking of the tissue adjacent to the veins. If leaf infection starts from the petiole, the main veins and their branches appear water-soaked at first and later take on a brick-red color. In plants infected with halo blight, the young leaves also may become mottled with pale-green and dark-green areas and the leaves may be slightly crinkled.

Symptoms produced on stems, pods, and seeds by the common-blight organism are usually indistinguishable from those produced by the halo-blight organism, except where bacterial exudate or ooze is found in the lesions (Fig 4). For common blight this exudate is of a yellowish color, while with halo blight the ooze is of a light cream color.



FIG. 3—Halo blight on leaves and pod of snap beans. The halo areas are especially prevalent at the edges of the leaves.

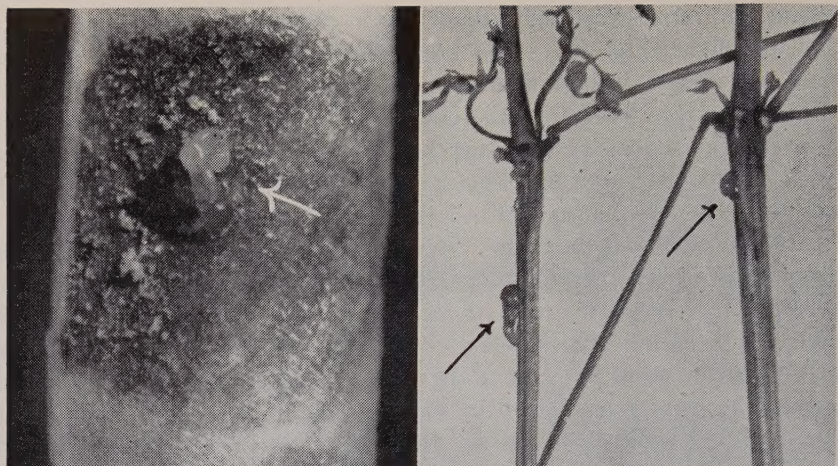


FIG. 4—Bacterial ooze of blight: on left, an infected pod; and right, infected stems.

Lesions on stems appear as sunken, water-soaked spots which gradually enlarge and become streaks longitudinal with the stem. Later they become reddish-brown in color and often cause splitting of the stem in which bacterial exudate may accumulate (Fig. 4). Stems of infected plants may be completely girdled just above the primary node, causing the plants to become weakened and to fall over.

Infections of pods may occur at any place, first appearing as small, water-soaked areas. These may gradually enlarge until the entire pod is



FIG. 5—Mature pods severely spotted by bacterial blight. Bacterial ooze has hardened at the centers of lesions.



FIG. 6—Bacterial wilt of beans. The numerous dead areas on the leaves were caused by systemic invasion of the plant by the causal bacteria.

covered (see front cover). At first the lesions are dark-green, but they may become dry, sunken, and reddish-brown in color (Fig. 5). Infection of pod sutures is common, causing a water-soaking of the adjoining tissue.

Blight organisms may infect the seed by either working their way through the pod tissue from local infections on the outside, or by entering the seed through the vascular tissue. In white seed, the common-blight organism produces yellow spots and, if the entire seed is infected, it may be wrinkled and dark yellow. In halo blight the same condition is produced on white seeds with perhaps more of a maize-yellow or cream color. In dark-colored seeds it is almost always impossible to differentiate between the two diseases or other bacterial or fungus diseases that affect bean seeds. Severely infected seeds may be small, wrinkled, and completely colored by the pathogen. In extreme cases they may be almost completely destroyed.

Plants from infected seed may exhibit characteristic wilting or slight drooping of leaves, due largely to water loss. The leaves may regain a great deal of turgidity at night when water loss is reduced. Leaves may turn brown and cling to the plant; pods may wither and fail to produce seed. In very young plants the stalk dries, becomes moderately thin, and topples over. In many cases the plants are severely stunted and wilted. Premature death is very common, with systemic infection.

Fuscos blight resembles common blight so closely that identification is almost impossible without laboratory tests (10).

Bacterial Wilt

The bacterial wilt organism is primarily a vascular parasite; invasion has a decided tendency to become systemic in nature. Thus the general symptoms of a diseased plant are the most pronounced (Fig. 6). Stunting of an infected plant takes place and usually develops quickly into a wilt. Young plants 2 to 3 inches tall may be attacked and at that size are usually killed.

Leaves along the stems and branches of infected plants become flaccid and limp, and finally wilt, turn brown and die. The earliest symptoms are observed easiest during the warmest part of the day, when the leaves become flaccid. If the disease is not too far advanced, the leaves gradually regain their turgidity during the cooler part of the day.

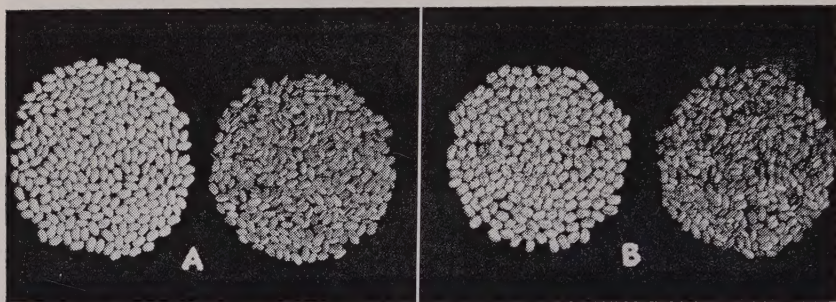


FIG. 7—Bean seeds which have shriveled and in some cases were killed by bacterial wilt. **A**, Great Northern beans: disease-free (left) and infected (right). **B**, Pinto beans: disease-free (left) and infected (right). Both halo and common blight may produce a similar condition in seeds.

Water-soaked lesions, characteristic of common and halo blights, are not conspicuous on stems, leaves, or pods affected by wilt. This disease may cause girdling of the stems or infection of the nodes. Infected nodes turn red and are greatly weakened so that the plant is broken off easily during a windstorm. Stem girdle is also found in plants infected with common and halo blight.

Lesions produced on pods by the wilt organism occur along the suture, causing a dark-green, water-soaked spot sometimes extending the entire length of the pod. If the disease appears on pods at places other than along the sutures, the spots are occasionally water-soaked and resemble those caused by common and halo blights.

The wilt organism may penetrate the hilum or “eye” of the seed and form

yellow masses of bacteria under the seed coat; or, without entering the seed, the organism may form incrustations on the outer surfaces. Infected seed of white-seed varieties is conspicuously yellow with bright-yellow masses of bacteria visible through the seed coat, but they are not easily recognized in beans with colored seed coats (Fig. 7). Severely infected seed may be very wrinkled and appear as if varnished.

CAUSE OF BACTERIAL BLIGHTS

The organisms causing bacterial diseases of bean are: common blight, *Xanthomonas phaseoli* (Smith) Dowson; halo blight, *Pseudomonas phaseolicola* (Burk.) Dowson; bacterial wilt, *Corynebacterium flaccumfaciens* (Hedges) Dowson; and fuscous blight, *Xanthomonas phaseoli* var. *fuscans* (Burk.) Starr and Burkholder.

The causal bacteria usually enter bean plants through the stomata or breathing pores of leaves, stems, and pods. The bacteria are spread from plant to plant by wind, heavy dews, driving rains, and hailstorms. Damp weather favors development of the bacteria especially in common and halo blights. Man and animals walking through fields, as well as use of machinery in fields while the plants are wet, greatly facilitate spread of the bacteria. Insects also have been reported to spread blight from plant to plant (4). Warm temperatures favor common blight and bacterial wilt, whereas cool temperatures favor halo blight.

In addition to being carried in the seed, the bacteria can live over winter on dead plant material in the soil, possibly for two or more years.

EXPERIMENTAL WORK

Resistant Varieties

Several hundred selections of beans, which were obtained by the Federal Horticultural Station at Cheyenne, Wyoming, from various parts of the world, have been tested at Laramie and at the Powell Substation in hopes of finding varieties of snap beans resistant to halo blight. A number of these selections showed considerable resistance to the halo-blight organism. Most of these selections showed viny, flat-podded, and late-maturing characteristics which are not desirable in snap beans. Further testing and selecting will be conducted to obtain resistant material to use in a breeding program in order to obtain a variety of snap beans suitable for Wyoming conditions. This is a long-range program; immediate results cannot be expected.

In a preliminary test conducted at Powell in 1951, 40 varieties, including the Wyoming Pinto selections and all other commercial varieties obtainable, were tested for resistance to bacterial wilt. None of the commonly grown varieties showed a high degree of resistance. Percentage of infection obtained is shown in Table 1.

Dusting for Control of Halo Blight

Dusting experiments, in which a number of copper compounds were tested to prevent secondary spread of the halo-blight bacteria, have been conducted at Powell since 1947. Dusting sulfur was used as a carrier for these compounds to prevent development of rust. The amount of copper, expressed as metallic copper in each compound, ranged from 7 to 10 percent. The dusts were applied three times during the growing season at rate of 20 to 30 pounds per acre.

Copper oxychloride, copper sulfate, and yellow cuprocide were effective in greatly reducing the spread of halo blight. Copper oxychloride gave best results.

Although use of dusts has given some benefit in checking the spread of blight, sufficient work has not been done to warrant a recommendation for use of dusts. Since tolerance for halo blight in seed beans is very low, applications of dusts would have to be applied from the seedling stages until the pods were mature, to obtain satisfactory control. It is doubtful whether the expense of material and labor would justify their use.

TABLE 1—Percentage of Plants Infected with Bacterial Wilt in the Bacterial Wilt Variety-resistance Test.

Variety		Percentage of plants Infected	Variety		Percentage of plants Infected
Wyoming Pintos*			Great Northern		
Adams.....	No. 1	11	U. I.†.....	No. 15	36
	No. 2	12	U. I.	No. 16	26
	No. 3	26	U. I.	No. 31	40
	No. 4	21	U. I.	No. 59	21
	No. 5	13	U. I.	No. 81	32
	No. 6	15	U. I.	No. 123	23
	No. 7	11	Mont.	No. 1	24
	No. 8	16	Mont.	No. 5	28
	No. 9	12	Hall Striped	Pod	18
	No. 10	22	Powell Station		26
Torrington.....	No. 1	16	Striped Pod		
	No. 3	6	Small flat white		
	No. 10A	17	U. I.	No. 1	25
	No. 25	14	Small round		
	No. 34	20	U. I.	No. 5	13
	No. 39	30	Pinto		
	No. 48	8	U. S.	No. 5	33
	No. 56	19	U. S.	No. 14	39
	No. 62	21	U. I.	No. 72	28
	No. 88	17	U. I.	No. 78	28
Red Mexican U. I.	No. 3	26	U. I.	No. 111	30
Red Mexican U. I.	No. 34	21	Scottsbluff		10

*Lines increased from individual plant selections. The Adams selections were made on the Adams Brothers' Farms near Riverton and the Torrington selections were made on the Torrington Substation.

†Varieties introduced by the University of Idaho (U. I.).

Use of Antibiotics

In 1947 work was started at Laramie to determine whether antibiotics would be effective in control of halo blight. One percent streptomycin sulfate solution gave promise of control in preliminary tests. No symptoms of blight were evident on plants grown in the greenhouse for periods of six weeks from naturally-infected seed and treated for 15 minutes. However, when such treated seed was grown in field plots, blight eventually appeared, and it was necessary to increase the period of treatment to 30 minutes. Even then, blight symptoms appeared occasionally, so the treating period was extended to 60 minutes. With increase in treating time, seed coats were found to slip and germination reduced. A 10 percent liquid latex solution was then employed. Infected seed was placed in the latex for 30 minutes and then placed in the antibiotic solution. Latex did not reduce effectiveness of the streptomycin sulfate but did prevent the seed coat from slipping.

Field tests have been conducted at the Experiment Station at Laramie and at substations located at Powell and Torrington. Results of these tests were favorable with treating periods up to 60 minutes with streptomycin sulfate. More work should be done on different methods of treatment before recommendations are made. Also, the cost of antibiotics purified and sterilized for human use is too expensive to use on large quantities of seed. However, if the treatment continues to be successful, crude and non-sterilized material can be obtained and used on small lots of seed in seed plots and on small fields which would provide seed for larger planting the following year.

Numerous other antibiotics are being tested to determine their effectiveness in controlling blight.

CONTROL MEASURES

The most effective control measures of bacterial diseases of beans are use of disease-free seed, rotation, and good cultural practices.

Use of disease-free seed. Use of healthy seed cannot be emphasized too strongly. Disease-free seed usually commands a premium in price but is worth the cost. Seed should be obtained from a reputable source.

Rotation. Rotation of three years between crops of beans is essential and is sufficient to dispose of overwintering organisms. A clean-up of old vines is desirable as a general sanitary measure; it probably would reduce chances of infection where rotation of the bean crop is short.

Cultural practices. Since bacteria adhere to clothing and machinery, it is advisable to avoid working in the fields when the plants are wet. Cultivation and picking operations performed while plants are wet can rapidly spread the bacteria from a few infected plants to healthy plants throughout the field.

Isolation of fields of snap beans and seed beans should be rigidly practiced to prevent spread of blight to these fields.

At present other measures such as resistant varieties, seed treatment, and spraying and dusting are of lesser importance in controlling bacterial blights.

Bean varieties vary in susceptibility to common and halo blight, but a given variety may react differently to each disease organism. At present no commercially grown varieties of beans possess a high degree of resistance to common blight. Several varieties of field beans such as Great Northern, Pinto, and Red Mexican and a number of semipole and pole garden-bean varieties possess some resistance to halo blight. Little is known about resistance of dry and snap beans to bacterial wilt and to fuscous blight.

Seed treatment with disinfectants is of questionable value since the organism is carried beneath the seed coat and is inaccessible to the materials unless treatment is rather long, in which case germination may be impaired. Use of antibiotics for seed treatment has shown some promise, but further work needs to be done before they can be recommended.

Spraying and dusting have not been found generally very effective in controlling blight of beans, especially with beans grown for seed where the tolerance for blight is very low. Use of fungicides might be advisable with commercial beans to reduce the percentage of disease, where the material can be applied in combination with insecticides or other fungicides for control of insects or rust.

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